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HD **DOOMSDAY IS (NOT) COMING**
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Yes, there are threats facing the planet, says Steven Pinker. But we know there's one measure that will not make the world safer: moaning that we're doomed

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Doomsday is hot. For decades, we have been terrified by dreadful visions of civilization-ending overpopulation, resource shortages, pollution and nuclear war. But recently, the list of existential menaces has ballooned. We now have been told to worry about nanobots that will engulf us, robots that will enslave us, artificial intelligence that will turn us into raw materials and teenagers who will brew a genocidal virus or take down the internet from their bedrooms.

Scientists and technologists have been deploying their ingenuity to identify ever more ways in which the world will soon end. In 2003, the eminent astrophysicist Martin Rees published a book entitled Our Final Hour in which he warned that "humankind is potentially the maker of its own demise" and laid out some dozen ways in which we have "endangered the future of the entire universe."

For example, experiments in particle colliders could create a black hole that would annihilate the Earth, or a "strangelet" of compressed quarks that would cause all matter in the cosmos to bind to it and disappear.

Techno-philanthropists have bankrolled research institutes dedicated to discovering new existential threats and figuring out how to save the world from them, including the Future of Humanity Institute, the Future of Life Institute, the Center for the Study of Existential Risk and the Global Catastrophic Risk Institute.

How should we think about the existential threats that lurk behind the vast incremental progress the world has enjoyed in longevity, health, wealth and education? No one can prophesy that a cataclysm will never happen. But, as with our own mortality, there are wise and foolish ways of dealing with the threats to our existence. Some threats turn out to be figments of cultural and historical pessimism. Others are genuine, but we must treat them not as apocalypses-in-waiting but as problems to be solved.

At first glance, one might think that the more thought we give to existential risks, the better. The stakes, quite literally, could not be higher. What harm could there be in getting people to think about these terrible risks?

The worst that could happen is that we would take some precautions that turn out in retrospect to have been unnecessary.

But apocalyptic thinking has serious downsides. One is that false alarms to catastrophic risks can themselves be catastrophic.

The nuclear arms race of the 1960s, for example, was set off by fears of a mythical "missile gap" with the Soviet Union. The 2003 invasion of Iraq was justified by the uncertain but catastrophic possibility that Saddam Hussein was developing nuclear weapons and planning to use them against the United States. (As George W.

Bush put it, "We cannot wait for the final proof – the smoking gun – that could come in the form of a mushroom cloud.") And one of the reasons the great powers refuse to take the common-sense pledge that they won't be the first to use nuclear weapons is that they want to reserve the right to use them against other supposed existential threats such as bioterror and cyberattacks. Sowing fear about hypothetical disasters, far from safeguarding the future of humanity, can endanger it.

A second hazard of enumerating doomsday scenarios is that humanity has a finite budget of resources, brainpower and anxiety. You can't worry about everything. Some of the threats facing us, such as climate change and nuclear war, are unmistakable, and will require immense effort and ingenuity to mitigate. Folding them into a list of exotic scenarios with minuscule or unknown probabilities can only dilute the sense of urgency. Cognitive psychologists have shown that people are poor at assessing probabilities, especially small ones, and instead play out scenarios in their mind's eye. If two scenarios are equally imaginable, they may be considered equally probable, and people will worry about the genuine hazard no more than about the science-fiction plot line. And the more ways people can imagine bad things happening, the higher their estimate that something bad will happen.

And that leads to the greatest danger of all: that reasonable people will think, as a 2016 New York Times article put it, "These grim facts should lead any reasonable person to conclude that humanity is screwed." If humanity is screwed, why sacrifice anything to reduce potential risks?

Why forgo the convenience of fossil fuels or exhort governments to rethink their nuclear weapons policies? Eat, drink and be merry, for tomorrow we die! A 2013 survey in four English-speaking countries showed that among the respondents who believe that our way of way of life will probably end in a century, a majority endorsed the statement, "The world's future looks grim so we have to focus on looking after ourselves and those we love."

Few writers on technological risk give much thought to the cumulative psychological effects of the drumbeat of doom. As Elin Kelsey, an environmental communicator, points out, "We have media ratings to protect children from sex or violence in movies, but we think nothing of inviting a scientist into a second-grade classroom and telling the kids the planet is ruined. A quarter of [Australian] children are so troubled about the state of the world that they honestly believe it will come to an end before they get older." According to recent polls, so do 15 per cent of people worldwide, and between a quarter and a third of Americans. In *The Progress Paradox*, the journalist Gregg Easterbrook suggests that a major reason that Americans are not happier, despite their rising objective fortunes, is "collapse anxiety": the fear that civilization may implode and there's nothing anyone can do about it.

Of course, people's emotions are irrelevant if the risks are real. But risk assessments fall apart when they deal with highly improbable events in complex systems. Since we cannot replay history thousands of times and count the outcomes, a statement that some event will occur with a probability of .01 or .001 or .0001 or .00001 is essentially a readout of the assessor's subjective confidence.

This includes mathematical analyses in which scientists plot the distribution of events in the past (such as wars or cyberattacks) and show they fall into a powerlaw distribution, one with "fat" or "thick" tails, in which extreme events are highly improbable but not astronomically improbable.

The math is of little help in calibrating the risk, because the scattershot data along the tail of the distribution generally misbehave, deviating from a smooth curve and making estimation impossible. All we know is that very bad things can happen.

That takes us back to subjective readouts, which tend to be inflated by the Availability and Negativity biases and by the market among social commentators for gravitas: Those who sow fear about a dreadful prophecy may be seen as serious and responsible, while those who are measured are seen as complacent and naive.

Despair springs eternal. At least since the Hebrew prophets and the Book of Revelation, prophets have warned their contemporaries about an imminent doomsday. Forecasts of End Times are a staple of seers, psychics, mystics, televangelists, nut cults, founders of religions and men pacing the sidewalk with sandwich boards saying "Repent!" The storyline that climaxes in harsh payback for technological hubris is an archetype of Western fiction, including Promethean fire, Pandora's box, Icarus's flight, Faust's bargain, the Sorcerer's Apprentice, Frankenstein's monster and, from Hollywood, more than 250 end-of-the-world flicks. As author and academic Eric Zencey has observed, "There is seduction in apocalyptic thinking. If one lives in the Last Days, one's actions, one's very life, take on historical meaning and no small measure of poignance."

Scientists and technologists are by no means immune.

Remember the Y2K bug? In the 1990s, as the turn of the millennium drew near, computer scientists began to warn the world of an impending catastrophe. In the early decades of computing, when information was expensive, programmers often saved a couple of bytes by representing a year by its last two digits. They figured that by the time the year 2000 came around, and the implicit "19" was no longer valid, the programs would be long obsolete.

But complicated software is replaced slowly, and many old programs were still running on institutional mainframes and embedded in chips. When 12 a.m.

on Jan. 1, 2000, arrived and the digits rolled over, a program would think it was 1900 and would crash or go haywire (presumably because it would divide some number by the difference between what it thought was the current year and the year 1900, namely zero, although why a program would do this was never made clear). At that moment, bank balances would be wiped out, elevators would stop between floors, incubators in maternity wards would shut off, water pumps would freeze, planes would fall from the sky, nuclear power plants would melt down and intercontinental ballistic missiles would be launched from their silos.

And these were the hardheaded predictions from techsavvy authorities (such as president Bill Clinton, who warned the nation, "I want to stress the urgency of the challenge. This is not one of the summer movies where you can close your eyes during the scary part"). Cultural pessimists saw the Y2K bug as comeuppance for enthraling our civilization to technology. Among religious thinkers, the numerical link to Christian millennialism was irresistible. The Reverend Jerry Falwell declared, "I believe that Y2K may be God's instrument to shake this nation, humble this nation, awaken this nation and from this nation start revival that spreads the face of the earth before the Rapture of the Church." A hundred billion dollars was spent worldwide on reprogramming software for Y2K Readiness, a challenge that was likened to replacing every bolt in every bridge in the world.

As a former assembly language programmer, I was skeptical of the doomsday scenarios, and fortuitously I was in New Zealand, the first country to welcome the new millennium, at the fateful moment. Sure enough, at 12 a.m.

on Jan. 1, nothing happened (as I quickly reassured family members back home on a fully functioning telephone). The Y2K reprogrammers, like the elephant-repellent salesman, took credit for averting disaster, but many countries and small businesses had taken their chances without any Y2K preparation, and they had no problems, either.

Although some software needed updating (one program on my laptop displayed "Jan. 1, 19100"), it turned out that very few programs, particularly those embedded in machines, had both contained the bug and performed furious arithmetic on the current year. The threat turned out to be barely more serious than the lettering on the sidewalk prophet's sandwich board. The Great Y2K Panic does not mean that all warnings of potential catastrophes are false alarms, but it reminds us that we are vulnerable to techno-apocalyptic delusions.

How should we think about catastrophic threats? Let's begin with the greatest existential question of all, the fate of our species. As with the more parochial question of our fate as individuals, we assuredly have to come to terms with our mortality. Biologists joke that to a first approximation all species are extinct, since that was the fate of at least 99 per cent of the species that ever lived. A typical mammalian species lasts around a million years, and it's hard to insist that *Homo sapiens* will be an exception. Even if we had remained technologically humble hunter-gatherers, we would still be living in a geological shooting gallery. A burst of gamma rays from a supernova or collapsed star could irradiate half the planet, brown the atmosphere and destroy the ozone layer, allowing ultraviolet light to irradiate the other half. Or the Earth's magnetic field could flip, exposing the planet to an interlude of lethal solar and cosmic radiation. An asteroid could slam into the Earth, flattening thousands of square miles and kicking up debris that would black out the sun and drench us

with corrosive rain. Supervolcanoes or massive lava flows could choke us with ash, CO₂ and sulfuric acid. A black hole could wander into the solar system and pull the Earth out of its orbit or suck it into oblivion. Even if the species manages to survive for a billion more years, the Earth and solar system will not: The sun will start to use up its hydrogen, become denser and hotter and boil away our oceans on its way to becoming a red giant.

Technology, then, is not the reason that our species must some day face the Grim Reaper.

Indeed, technology is our best hope for cheating death, at least for a while. As long as we are entertaining hypothetical disasters far in the future, we must also ponder hypothetical advances that would allow us to survive them, such as growing food under lights powered with nuclear fusion, or synthesizing it in industrial plants such as biofuel. Even technologies of the not-so-distant future could save our skin. It's technically feasible to track the trajectories of asteroids and other "extinction-class near-Earth objects," spot the ones that are on a collision course with the Earth and nudge them off course before they send us the way of the dinosaurs. NASA has also figured out a way to pump water at high pressure into a supervolcano and extract the heat for geothermal energy, cooling the magma enough that it would never blow its top. Our ancestors were powerless to stop these lethal menaces, so in that sense, technology has not made this a uniquely dangerous era in the history of our species but a uniquely safe one.

For this reason, the technoapocalyptic claim that ours is the first civilization that can destroy itself is misconceived. As Ozymandias reminded the traveller in Percy Bysshe Shelley's poem, most of the civilizations that have ever existed have been destroyed.

Conventional history blames the destruction on external events such as plagues, conquests, earthquakes or weather. But the physicist David Deutsch points out those civilizations could have thwarted the fatal blows had they had better agricultural, medical or military technology: "Before our ancestors learned how to make fire artificially (and many times since then, too), people must have died of exposure literally on top of the means of making the fires that would have saved their lives, because they did not know how. In a parochial sense, the weather killed them; but the deeper explanation is lack of knowledge."

A judicious look at threats to global well-being is not a call to complacency but the opposite. It is a call to prioritize the threats, identify the means to mitigate them and work toward implementing and strengthening these measures with all deliberate speed.

Some threats strike me as the 21st-century version of the Y2K bug. This includes the possibility that we will be annihilated by artificial intelligence, whether as direct targets of their will to power or as collateral damage of their single-mindedly pursuing some goal we give them. The first threat depends on a confusion of intelligence with dominance: Those traits are bundled together in *Homo sapiens*, but an intelligence that is designed rather than having evolved needn't be saddled with ruthless megalomania. The second depends on the premises that (1) humans are so gifted that they can design an omniscient and omnipotent AI, yet so idiotic that they would give it control of the universe without testing how it works, and (2) the AI would be so brilliant that it could figure out how to transmute elements, rewire brains and other superpowers, yet so imbecilic that it would wreak havoc based on elementary blunders of misunderstanding.

Other threats are less fanciful, but are already being blunted.

Contrary to Malthusian predictions of teeming populations eating themselves into mass starvation, the world has been increasingly feeding itself. The reasons include advances in agronomy, the spread of democratic governance and especially the demographic transition: As countries escape extreme poverty and illiteracy, their people choose to have fewer children. The predictions of catastrophic resource depletion have been repeatedly falsified, too, by a combination of technology and markets. As the most easily extracted supply of a resource becomes scarcer, its price rises, encouraging people to conserve it, get at the less accessible deposits or find cheaper and more plentiful substitutes.

This leaves still other threats which are real and nowhere near being solved: climate change and nuclear war. But unsolved does not mean unsolvable. Pathways to decarbonizing the economy have been mapped out, including carbon pricing, zero-carbon energy sources and programs for carbon capture and storage. So have pathways to denuclearization, including strengthening international institutions, de-alerting nuclear forces, stabilizing systems of deterrence and verifiably reducing (and eventually eliminating) nuclear arsenals.

The prospect of meeting these challenges is by no means utopian. The world has dealt with global challenges in the past, including atmospheric nuclear testing and the ozone hole. It has survived half-mad despots with nuclear weapons, namely Stalin and Mao, and episodes of dangerous brinkmanship during the

Cold War. It has reduced nuclear arsenals by 85 per cent, and the amount of CO2 emitted per dollar of GDP by 44 per cent. Implementing the measures that will drive these numbers all the way down to zero will require enormous amounts of persuasion, pressure, and will.

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